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AFATL-TR-71-58

LIGHTWEIGHT RIFLE/SUBMACHINE GUN

COLT'S INC, MILITARY ARMS DIVISION

TECHNICAL REPORT AFATL-TR-71-58

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Lightweight Rifle/Submachine Gun

Stanley D. Silsby

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FOREWORD

This technical report documents work performed during the period 23 December 1969 to 23 December 1970 by Colt's Inc, Military Arms Division, 150 Huyshope Avenue, Hartford, Connecticut 06102, under contract F08635-70-C-0022 with the Air Force Armament Laboratory, Air Force Systems Command, Eglin Air Force Base, Florida 32542. Mr. Dale M. Davis (DLD) was program monitor for the Armament Laboratory.

This is the final report on design, fabrication, and testing of the lightweight rifle/submachine gun, and was prepared by Mr. S. D. Silsby, Project Engineer, Military Engineering, Colt's Inc.

This report has been reviewed and is approved.


B. LEMUEL D. HORTON, Colonel, USAF
Chief, Guns and Rockets Division

ABSTRACT

The object of this program was to design and fabricate four demonstrator weapons to be used by the Air Force Armament Laboratory, Eglin Air Force Base, Florida, to prove the feasibility of its automatic weapon concept which utilizes the shooter's arm as the gunstock.

Demonstrations proved the basic concept was not only feasible but exceeded expectations. Further efforts will be made to improve trigger pull, trigger guidance, pistol grip locking, the arm rest, sighting, and to modify the design for quantity production.

The origin of the stockless rifle and machine gun is described in the publication, "Ordnance", American Ordnance Association, September - October 1970, under the title "A Novel Survival Weapon" by Dale M. Davis.

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SECTION I

ORIGIN AND BACKGROUND

The lightweight rifle/submachine gun concept originated at a meeting of the American Ordnance Association Small Arms and Small Arms Ammunition Division held at Aberdeen Proving Ground on 2 and 3 May 1967. Mr. Hans Siewers, Life Support Equipment Requirements Officer, Strategic Air Command, Offut Air Force Base, Nebraska, in his paper titled "Air Force Survival Weapons", outlined the desired characteristics of a survival weapon as follows:

- (1) Capable of killing a man at 100 yards
- (2) Sufficiently accurate for the average aircrewman to hit a man at 100 yards
- (3) Not over 15.5 inches in length (later reduced to 13 inches)
- (4) Not over 1 inch thick
- (5) Not over 39 cubic inches in volume
- (6) Not over 1.5 pounds in weight
- (7) Semiautomatic
- (8) A magazine capacity of at least seven rounds.

No presently produced pistol or rifle fulfills these requirements. A pistol is not accurate at 100 yards in the hands of the average aircrewman and a rifle greatly exceeds the weight and size limitations.

Mr. Dale M. Davis, Air Force Armament Laboratory, Eglin AFB, Florida, decided to develop a weapon concept to meet the above requirements. Since the weapon need not fire more than 100 rounds in its lifetime, light alloys within the weight constraints could be used for many of the components. Therefore, the first problem was to select the minimum cartridge that would kill a man at 100 yards. As a result of efforts of U. S. A. TECOM, a .17 caliber cartridge based on the Frankford/SPIW case which fired a 25-grain bullet at 3000 ft/sec had been developed. It measured 1.725 inches in length and 0.333 inch in diameter at the base. Since this round permitted design of a semiautomatic weapon within the weight and dimensional constraints specified, it was selected for the survival rifle.

The next problem area was the stock, whose functions are defined as follows:

- (1) To support the barrel and action
- (2) To provide a handhold for the left hand to steady the weapon
- (3) To transfer recoil to the shooter's shoulder
- (4) To provide a cheek rest.

Folding, telescoping, detachable, and wire skeleton stocks were considered. All of these except the wire skeleton exceeded either weight, volume, or dimensional restrictions. The wire stock has never been satisfactory, however, because it does not provide a cheek rest.

Consideration was then given to what an aircrewman might have with him when he bailed out or what he might find on the ground which could serve as a stock. The only practical solution was the man's arm. The extended arm is much like a stock in that the forearm functions as a forestock, supporting the barrel and action and providing a hand grip for the left hand, and the upper arm functions as the buttstock, transmitting recoil to the shoulder and providing a cheek rest. Attachment of the barrel and action to the stock (arm) was to be by a handgrip for the right hand near the muzzle which allowed the action to lie across the forearm at approximately 45 degrees, and held lightly in place by the left thumb. A wooden mock-up of the above concept, fabricated in June 1967, disclosed the problem that the stocks (arms) were non-standard. This was solved by making the handgrip with a 30 degree rearward rake and pivoting it about the barrel so that it can be held vertically on the inside of the arm (or at a 45 degree angle as described). Handling of the mock-up by several people disclosed that it could be held comfortably and that it was easier (for all except skilled rifle target shooters who were used to heavy target rifles) to hold a steady sight

picture than with a standard rifle.

To determine whether a gun would have the advantages displayed by the mock-up, a Remington XP 100 pistol was modified to a single shot test weapon configured like the mock-up and chambered for the .221 caliber Remington Fireball cartridge with a 50-grain projectile and a muzzle velocity of 2,530 ft/sec.

First firing of the modified XP 100 evidenced no sense of recoil whatsoever. The only sensation on the part of the shooter was the feeling that the handgrip became hard, i.e., like a change from wood to metal, because the hand that receives the recoil is one of the toughest parts of the body, and the arm and shoulder are elastic.

Muzzle climb on firing was about $\frac{1}{2}$ to $\frac{3}{4}$ inch; however, recovery was rapid (in time for the shooter to observe target impact at 100 yards). This is due to the bore line (reaction) being low over the hand (restraint) so that the turning moment causing muzzle jump is low.

Further advantages discovered during firing were:

- (1) Left-handed shooters can fire the weapon quite well right-handed. With conventional rifles or pistols, considerable training of left-handed shooters is necessary for them to shoot right-handed. Therefore, recruit training in the use of this weapon will be much simpler.
- (2) It is quite easy to use the weapon with one hand (either hand), a distinct asset for a wounded man. The fact that the weapon rests on the forearm makes it much steadier than a pistol.
- (3) In addition to the "rifle" usage, the weapon turned out to be ideally suited to the submachine gun role. When fired from the hip, the weapon assumed a natural or instinctive pointing position and did not require the degree of two-handed coordination that the conventional submachine gun needs.
- (4) The light, compact nature of the weapon is obviously advantageous to the user who is in close quarters or is otherwise burdened, such as aircrews, tankers, artillerymen, or airborne troops. The method of carrying the weapon provides the advantage over conventional weapons that, when carried, it is held by the pistol grip in a ready position. The user need only raise his arm to a level position for a quick shot, or fully raise his arm to be in the rifle position.

The next questions that arose were those concerning lethality and recoil of the stockless rifle when fired with high-powered rounds. An M93 Mauser rifle chambered for the 7.62mm NATO cartridge was modified to the stockless configuration and a weight of 5.5 pounds. A conventional 7.62mm rifle of this weight would have excessive recoil. In the stockless configuration, however, it can be felt in the heel of the hand but is not uncomfortable. When fired from a standing position, there is considerable muzzle jump but less than that of 9-pound M14.

The concept was sufficiently promising to warrant further study. Of particular interest was what the behavior of the stockless weapon might be in full-automatic fire.

The caliber .221 cartridge was chosen for the demonstrator because it produced a weapon midway between the weapons of ultimate interest, a caliber .17 survival rifle and a 5.56mm rifle/submachine gun.

SECTION II

WEAPON DESCRIPTION

The lightweight rifle/submachine gun is a gas-operated weapon with the gas port near the muzzle of the barrel. The bolt has eight lugs and is forward-locking in the receiver. Semiautomatic and automatic fire are controlled by a selector located under the weapon where it can be reached equally well by left or right-handed shooters. A low rate of 500 rounds per minute is accomplished with an inertia delay device that retards hammer fall.

The pistol grip is mounted on the barrel and can be rotated to any of three positions: vertical for storage, 38 degrees to the right for right-handed shooters, or 38 degrees to the left for left-handed shooters. The arm rest and optical sight can be shifted from one side of the weapon to the other. There are three complete sets of iron sights to allow shooting from either hand.

All openings in the weapon are automatically covered when the action is closed.

SECTION III

TECHNICAL REQUIREMENTS

This section contains a discussion of the contractual requirements for this effort.

General

The delivered weapons are selectively automatic/semiautomatic firearms capable of being supported by the shooter's arm while firing. They can be fired either left-handed or right-handed.

Ammunition

Caliber

The weapons are chambered for the caliber .221 Remington Fireball cartridge. The basic design can be used for a caliber .17 cartridge (not yet developed), or the 5.56mm Government cartridge (caliber .223 Remington).

Type

The weapons are chambered and powered for caliber .221, 50-grain, Remington Fireball ammunition. The velocity of this ammunition is 2,400 ft/sec.

Action

The action is gas operated with the gas cylinder above the barrel. The bolt has eight lugs and is front-locking. The locking cam is in the bolt carrier and the cam pin is guided in a slot in the top of the receiver. This slot also serves as an ejection opening. The firing pin is retained by a cross pin which also prevents firing pin protrusion until the bolt is completely locked. The extractor is a modified M16 component. The ejector is spring operated.

Feed Magazines

Two each ten-and thirty-round conventional, spring-loaded, detachable box magazines were supplied with each weapon.

Ejection

Ejection for a right-handed shooter is to the right but varies all the way from forward to rearward. Although this does not fully satisfy the requirement, it is not objectionable since the cases are traveling at low velocity.

Rate of Fire

Since the free cyclic rate of fire of a weapon as compact and lightweight as the lightweight rifle/submachine gun would be excessively high for automatic fire, it was necessary to devise a rate reducer that could be fitted within the space limitations. It is an inertia delay device integral with the automatic searing mechanism which retards hammer fall. Rate of fire with the rate reducer is 500 rounds per minute. The rate of fire can be increased to 650 rounds per minute with a lightweight reducer. While trying lower rates, it was found that the shooter had time to recover after each round, causing considerable motion of the weapon during automatic fire. The 500 rounds per minute rate appears to be desirable for most shooters. Obviously, weight can be removed as desired to obtain higher rates.

Handgrip

The handgrip has a rearward angle of 30 degrees and swivels about the barrel near the muzzle end. It may be locked in the vertical position or 38 degrees to the right or left of vertical.

Trigger

The trigger is protected by a guard and is connected to the sear by a rod. Trigger pull is between 4 and 8 pounds.

Weight

The weapon without magazine or attachments weighs 3.75 pounds.

Size

Overall Length

The overall length of the weapon, less flash suppressor, is 15.875 inches.

Barrel Length

The barrel length is 10 inches.

Length of "Pull"

The distance from the trigger to the rear of the receiver is 12 inches and the distance from the trigger to the foremost part of the rear edge of the handgrip is 2.5 inches.

Thickness

The width of the weapon is 1.07 inches.

Sighting Equipment

The weapons are equipped with individual iron sights for each of the three pistol grip positions. All have 1/16 inch post front sights, threaded for elevation adjustment. Three types of rear sights are provided, 60 degree "V" notch, square, and peep. The rear sights are adjustable for windage. Sight radius of the iron sights is 15.75 inches. Interrupted dovetail cuts are provided on each side of the receiver for mounting a Rickert/Franklin electric sight.

Safety

Proof

All weapons have been proof-fired with one high pressure test cartridge and magnetic particle inspected for cracks, seams, and other injurious defects.

Fire Selector

The selector has three positions, safe, semiautomatic, and automatic. When in the safe position, the sear is blocked by the selector.

Positive Lock

The weapons have a positive locking system in that the firing pin cannot protrude beyond the bolt face until the bolt is completely locked. This is accomplished by the retaining pin which passes through the carrier and the hole in the firing pin. The automatic sear prevents the hammer from falling until the bolt is locked.

Test Firing

During the test program, more than fifty rounds were fired from each weapon and the total rounds fired was well over one thousand. A copy of the test report is included in the Appendix of this report.

Arm Rest Attachment

A removable arm rest is provided that attaches to either side of the weapon for left-or right-handed shooters. When removed, it is small enough to fit within the 1-inch limit of a survival rifle.

Sketch

Figure 1 of this report is a sketch of the rifle/submachine gun; Figure 2 shows a cutaway view. Technical requirements have been satisfied in the design, development, and fabrication of the four delivered demonstrator weapons with the exception of the ejection pattern, weapon length, and width. However, the dimensional changes and the ejection requirement deviation have been approved by the sponsor. In addition to the contractual requirements, flash suppressors and dust covers which automatically seal the weapons when the actions are closed were provided with the four delivered weapons.

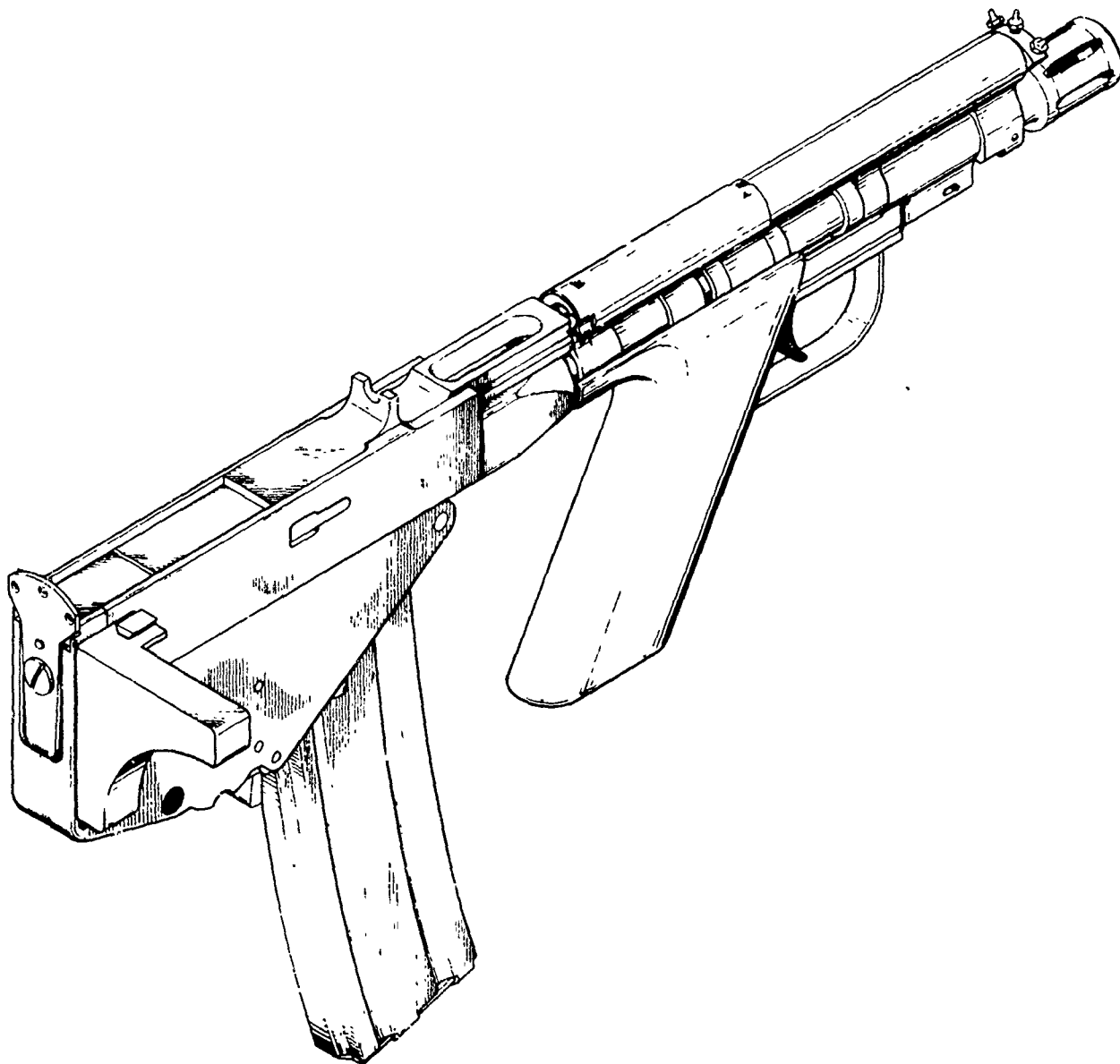


Figure 1. Lightweight Rifle/Submachine Gun

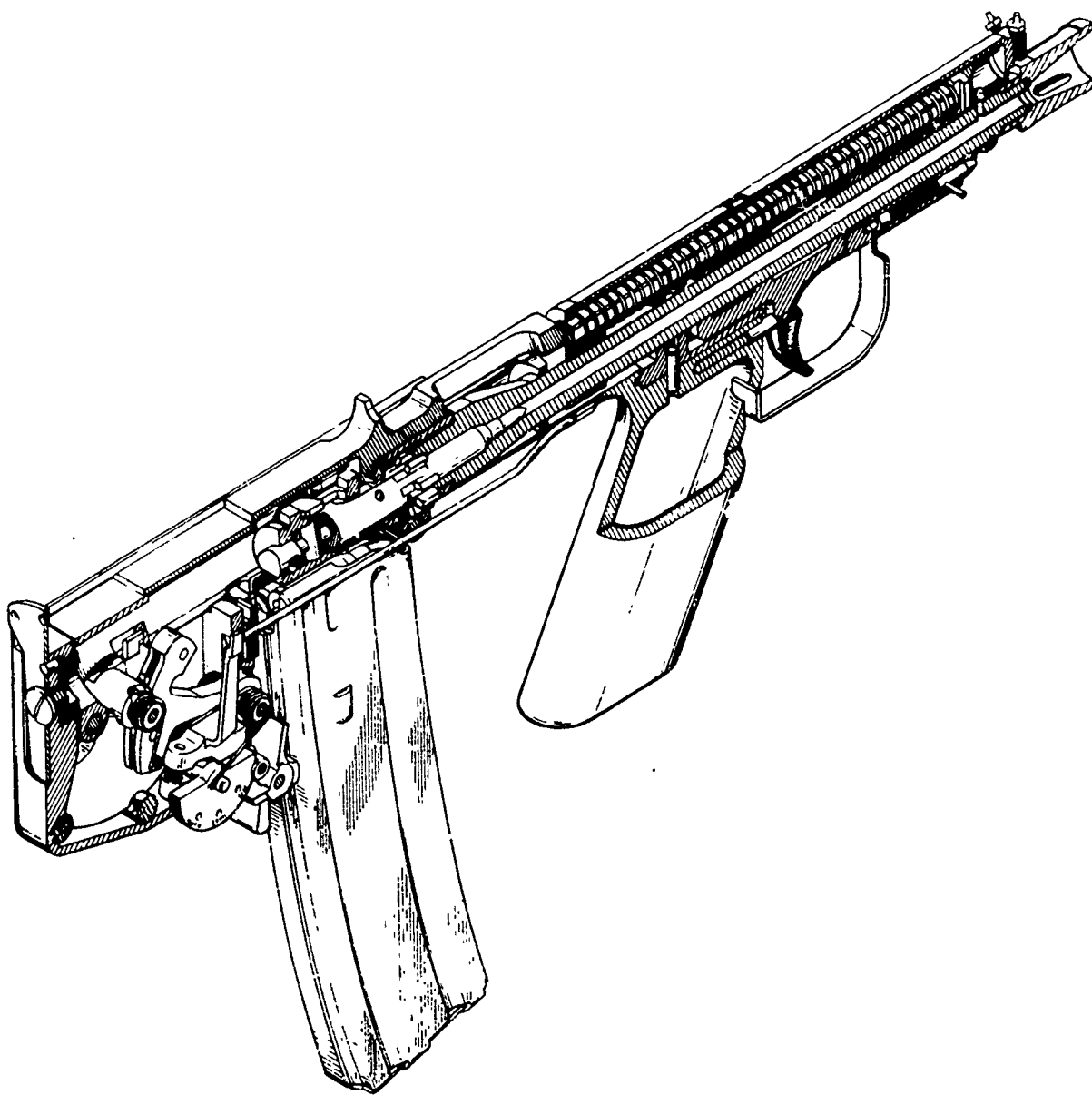


Figure 2. Lightweight Rifle/Submachine Gun (Cutaway)

SECTION IV

DESIGN

Iron Sights

The ideal location for the rear sight is in an area that must be kept clear for the charging handle and removal of the operating rod. An alternate design which places the rear sight on the operating spring stop results in a sight radius of 7-3/8 inches which is less than that specified in the requirements. The best solution to date is a peep sight mounted on the rear of the weapon.

Optical Sight Mount

The Rickert/Franklin electric sight and the arm rest are attached to the weapon by an interrupted tapered dovetail system. The included angle of the taper is 4 degrees. Recoil of the weapon locks the sight in place. Since tolerances on the dovetails are such that fabrication is strictly a hand-fitting operation, this design should not be considered for production.

Trigger Pull

Although the trigger pull falls within the requirement of a four-to-eight pound limit, it is not without faults. The long arm of the sear which is pushed by the trigger rod causes a longer than desirable pull. To improve on this would require a major design and modification effort which is impractical for the limited number of demonstrator weapons. If the entire linkage from trigger to sear is in proper condition, the pull is smooth. A stepped trigger pull effect can be obtained by substituting a spring system for the trigger return spring. This would let the shooter know when the sear is about to release (Figure 3). The only function of the trigger return spring is to prevent the trigger rod end from being jammed against the top of the sear arm when the lower receiver is swung up against the upper receiver.

Trigger Insulation

Trigger heating was anticipated during the early stages of design of the weapon and insulation was provided on the front surface of the prototype trigger. The amount of insulation proved to be inadequate so the triggers of the four delivered demonstrators were more thoroughly insulated.

Ejector

Ejector function in this weapon is at a disadvantage because the short caliber .221 case is at a steep angle at the point of release. At this angle, little energy remains in the ejector spring to spin the case out. This problem was anticipated and a larger ejector hole was provided in the bolt than in the M16 design. This allows for a somewhat heavier spring which is adequate.

Gas Cylinder

The gas cylinder diameter was determined by the operating spring size. Calculations indicated that a 1/2-inch diameter cylinder would accept an operating spring that would not be overstressed when delivering the required loads. As a gas cylinder, it is more than large enough to power the weapon.

Weight Ratio of Operating Components

The combined weight of the operating rod, bolt carrier, and retaining pin is 8.00 ounces. The weight of the bolt assembly and cam pin is 1.68 ounces. The resulting weight ratio of 4.8:1 assures smooth action of the weapon during bolt locking and unlocking.

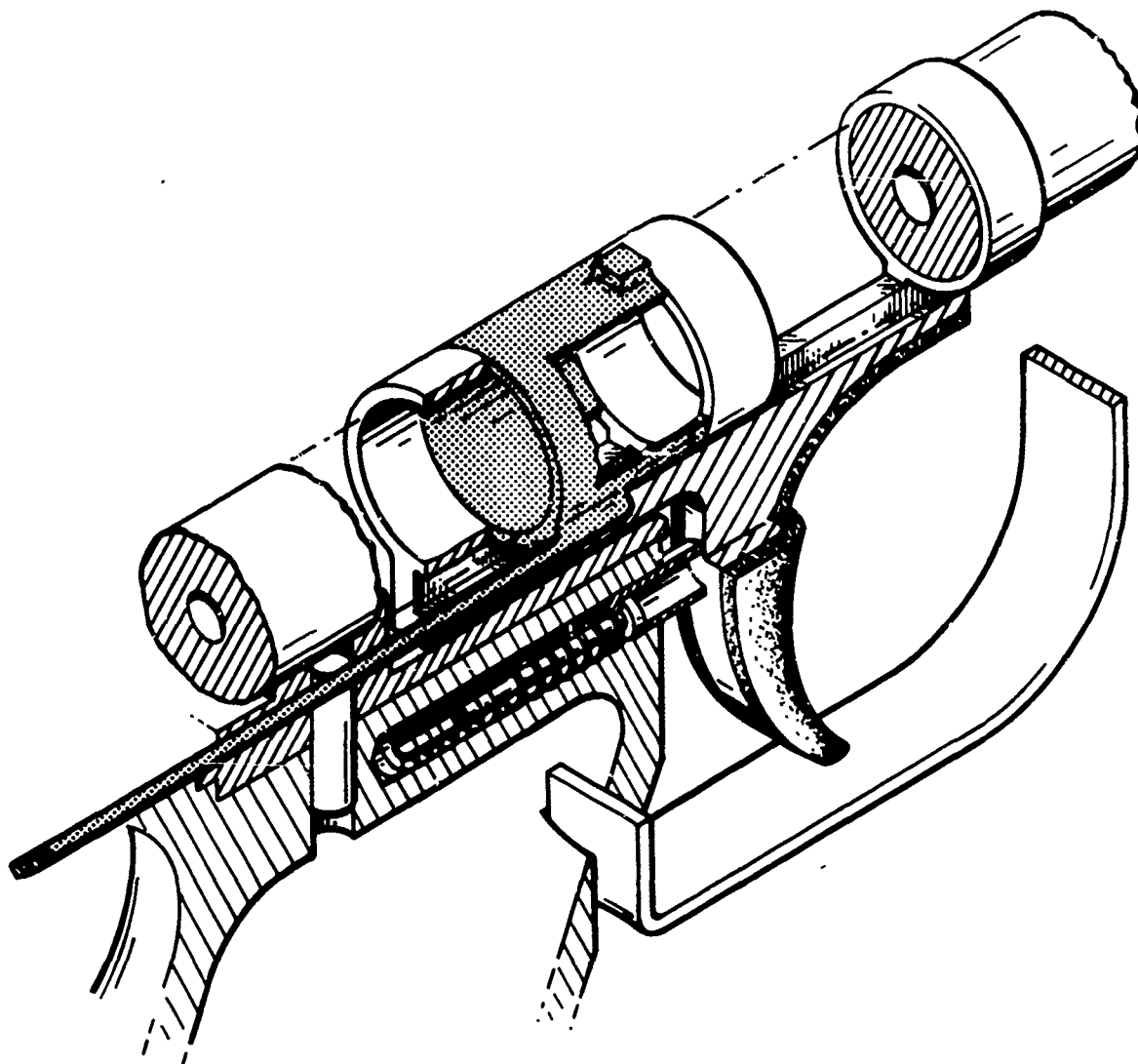


Figure 3. Substitute Spring System Concept for Trigger

Bolt Locking Lugs

Three materials were originally specified on the bolt drawing: 6150, 8650, or 4150 steel. The bolt in the prototype was fabricated of 6150 steel and no locking lug failures occurred, at least during firing of the first 4,000 rounds. The four demonstrator weapons, however, had bolts fabricated of 4150 steel, and locking lug breakage occurred after fewer than 2,000 rounds were fired. The bolt drawing has been revised and now specifies 4340 steel and a larger fillet in the extractor cut to eliminate breakage.

Weapon Safety

In designing the locking system and chamber area of the demonstrator weapons, the M16 was used as a guide. This was practical since the cartridges of the two weapons are identical except for length and the peak chamber pressure is only slightly less with the caliber .221 Fireball cartridge. The demonstrator weapon has an eight-lug bolt as opposed to the seven lugs of the M16 bolt. However, the total bearing area of the lugs in these weapons is identical. Also, the total cross section of the bolt lugs of the two weapons is identical and the total cross section of the lugs in the receiver of the demonstrator weapon is the same as that of the lugs in the M16 barrel extension. Chamber wall thickness and the threads on the rear of the barrels of the two weapons are identical. Obviously, the demonstrator weapons have a good safety factor in this area.

The bolt carrier assembly is designed with a 1/8-inch diameter pin passing through the carrier and a large hole in the rear of the firing pin. The purpose of this pin is to retain the firing pin and to prevent the firing pin from protruding beyond the bolt face until the bolt is locked. Unfortunately, a weapon was assembled with this pin passing behind the firing pin rather than through the hole. The weapon fired out of battery, damaging the bolt carrier and the cam pin. To prevent a recurrence of this, the firing pins have been staked at the rear to eliminate the possibility of incorrect assembly.

The Fireball cartridge, which was not designed for automatic fire, has a primer far more sensitive than the primer used in the caliber .223 cartridge (M16). To compensate for this, the firing pin was designed to be as light as possible and the free travel, determined by the retaining pin which passes through the hole in the rear of the firing pin, was held to a minimum. No known instance of the weapons being fired from firing pin inertia has been experienced.

Rate Reducer

A study was made to determine the most practical method of reducing rate of fire in the lightweight rifle machine gun. Some of the reasoning that led to the final decision was as follows:

One obvious method of rate reduction is to delay forward travel of the operating components as soon as possible after buffer contact. The operating components, in this case, weigh just over one-half pound and the operating spring has a force of nine pounds. An inertia device large and heavy enough to absorb an appreciable amount of this energy and the energy returned to the operating components by the buffer would not fit within the space limitations of the weapon. One other alternative is a timed latch; however, this could be complicated and expensive. Since delay is the key to rate reduction, the next step was to find some component which must move every time the weapon fires and possesses only a moderate amount of energy to accomplish this motion. The hammer met these requirements and had the added advantage that a compact and simple rate reducer could be incorporated in the automatic searing device that controls the hammer.

Testing this hammer delay system proved the choice to be a good one. The rate of fire was reduced the desired amount and the normal cycle of the operating components was not disturbed.

The importance of preserving buffer rebound energy and operating spring energy was not fully realized until the thirty-round magazines were tested. To obtain good function of the weapon with a fully loaded thirty-round

magazine it was necessary to use the largest operating spring that would fit in the 0.500-inch diameter gas cylinder and to utilize available buffer rebound energy.

SECTION V

RECOMMENDATIONS

The demonstrator weapon design, of which five models have been fabricated, was not intended for quantity production. The receiver, particularly for the survival rifle, would require considerable design effort to reduce overall cost. Many of the smaller components would require minor redesign to allow casting and forging economy. Some components, such as the trigger rod cover, could be molded of plastic.

To improve trigger pull, the firing mechanism components should be rearranged and their proportions changed. The selector could be relocated and made larger.

The trigger should be redesigned so that it is guided in the pistol grip rather than on the barrel.

The pistol grip lock is released by a small pin allowing the pistol grip position to be changed. A head should be provided for this pin.

The arm rest provided on the demonstrators is well suited to the survival rifle in that it fits within the one-inch limitation; however, a sturdier adjustable design should be provided for the rifle/submachine gun.

An effort should be made to improve the sights, either by a simple design breakthrough, or by adding enough hardware to provide adequate sighting for all shooters.

APPENDIX

This appendix contains developmental testing, acceptance testing, and ammunition testing test reports for the prototype and the four delivered demonstrator weapons.

.221 TEST REPORTS

I - DEVELOPMENTAL TESTING

a. Proof Firing

On 28 July, one proof-round was fired in gun no. 1. The gun was suspended on strings for firing. A magna-flux inspection of the gun after firing did not show any cracks.

b. Initial Function Firing

After proof-firing and magnaflux inspection, the weapon was mounted in a spring-loaded mount and fired for function. Two rounds were fired initially with a gas port diameter of 0.046 inch. The gun was underpowered. The gun appeared to have just unlocked. The gas port diameter was opened in steps corresponding to numbered drill sizes and the function checked at each step. At 0.062-inch diameter, the weapon ejected the fired case and the bolt carrier hit the buffer.

On 17 August the first automatic firing was done, using a modified M16 magazine. Overall function was sluggish, ejection was weak and erratic. There was one feed failure and one ejection failure in the first 50 rounds of automatic and semiautomatic firing.

c. Kinematics of Recoiling Parts

After the initial firing, the gas port was enlarged to 0.070-inch diameter in an attempt to correct the sluggish action of the gun. This did not correct the problem. At this point, time-displacement curves of the bolt carrier were taken. They showed that an interference in the rate-reducer area was taking energy from the bolt carrier. A modification was made to the rate reducer. Subsequent time-displacement curves showed that the interference was corrected and the motion of the bolt carrier was smooth.

On 24 August the gas port was peened back to 0.060-inch diameter, the feed ramp in the receiver socket stoned, and a new ejector spring installed. Function was then checked with and without the rate-reducer weight. Function was good in both conditions. More time-displacement curves were then taken with and without the rate-reducer weight. The curves indicated that the only effect of the rate-reducer weight on gun kinematics is to increase the dwell time of the bolt carrier in the battery position. The rate with the reducer weight was 434 spm; without the weight, 572 spm. In both conditions, the first cycle was approximately 5 percent lower than the average. Subsequent cycles were extremely consistent.

d. Ejection

Ejection was weak from the first firing. On 31 August, high-speed movies were taken to study the ejection function. The movies showed that a substantial part of the ejection weakness was caused by the manner in which the ejecting cases were hitting the operating rod. The shape of the operating rod was modified in the ejection port area. This improved the ejection considerably. During subsequent firing, occasional ejection failures were experienced but at low frequency.

e. Extraction

During the testing, what appeared to be a complete failure to eject was occasionally experienced. The fired case apparently never left the bolt face. This type of malfunction occurred with a frequency of approximately 1 per 100 rounds. On 2 October, a series of high-speed movies were taken in an attempt to discover the cause of this malfunction. The movies showed that the actual malfunction was a failure to extract rather than an ejection failure. The extractor dropped the fired case before the bolt had left the lugs in the receiver. A number of different attempts were made to solve the problem such as relieving the tang on the operating rod to make certain that it was not interfering with the extractor and reducing the width of the extractor at its front

end to decrease the possibility of gas blow-back lifting the extractor. Changing the extractor spring finally cured the malfunction.

f. Feeding

The first firing with the 30-round magazines showed that the gun was underpowered. It would not function with 30 rounds in the magazine. In order to increase the power of the gun, a more resilient material was used for the operating rod buffer, the gas port was enlarged, the operating spring loads increased, and bleed holes were drilled in the gas cylinder. This increased the power of the gun sufficiently to give good function with full 30-round magazines.

Rates of fire were determined after these modifications with 20 rounds in a 30-round magazine, 30 rounds in a 30-round magazine, and 10 rounds in a 10-round magazine with the rear-reducing weight removed. The average rates of fire were 480 spm, 435 spm, and 662 spm, respectively.

g. General Comments

A total of 4,000 rounds were fired in this gun. There were no broken parts. In the opinion of the test engineer, there are three human-engineering-type problems with the gun. One is the poor sight picture obtained with the sights, the second is the high temperatures which the trigger and surrounding area reach during sustained firing, and the third is the long, rather vague feeling trigger pull.

In the area of actual gun function, overall function is good with the exception of ejection which is somewhat marginal.

.221 TEST REPORTS

II - ACCEPTANCE TESTING

a. Proof Firing

Weapon numbers 2, 3, 4, and 5 were proof-fired on 10 December 1970. Weapon no. 2 fired out-of-battery because of incorrect assembly of the firing pin in the bolt. The bolt carrier, cam pin, and pistol grip were damaged and had to be replaced. Magnaflux inspection showed no cracks on any of the four guns.

b. Function Firing

Gun no. 2

A total of 570 rounds were fired with gun no. 2 during the function testing, using both 10-and 30-round magazines. Problems were experienced with the sear disconnect and ejection. The average cyclic rate for a 30-round burst was 522 spm. The time displacement curves were smooth and regular. There was no difficulty zeroing the weapon.

Gun no. 3

A total of 330 rounds were fired with gun no. 3, using both 10-and 30-round magazines. Initial function-firing produced a number of ejection failures. Minor modifications were made and subsequent function was good. Thirty-round average cyclic rate was 507 spm. The time-displacement curves were smooth and regular. There was no difficulty zeroing the weapon.

Gun no. 4

A total of 380 rounds were fired with gun no. 4, using both 10-and 30-round magazines. As with gun no. 3, ejection problems were initially encountered. Minor modifications greatly improved ejection. Average 30-round cyclic rate was 472 spm. The time-displacement curves were smooth and regular. No difficulty was encountered in zeroing the weapon.

Gun no. 5

A total of 270 rounds was fired from 10-to 30-round magazines with gun no. 5. Initial ejection failures were greatly reduced by minor modifications. Average 30-round cyclic rate was 489 spm. Time-displacement curves were smooth and regular. No difficulty was encountered in zeroing the weapon.

AF .221 TEST REPORTS

III - AMMUNITION TESTING

Samples of Remington .221 Fireball proof and 50-grain pointed soft-point ammunition were tested for pressure and velocity. The tests were done according to SAAMI procedures, using a pressure test barrel meeting SAAMI specifications.

A ten-round sample of Remington .221 Fireball proof ammunition, Lot BO2Y, was tested for chamber pressure.

A twenty-round sample of Remington .221 Fireball 50-grain pointed soft-point ammunition, Lot R19A, was tested for chamber pressure.

A ten-round sample of Remington .221 Fireball 50-grain pointed soft-point ammunition, Lot R19A, was tested for velocity at 15 feet.

The results were as follows:

Rem. Proof-Rounds (Lot BO2Y)	Average	Pressure (Copper Crusher)	Velocity at 15 feet
		64,640 CUP	
	High	69,000 CUP	
	Low	62,100 CUP	
Rem. 50-grain Pointed Soft-Point Rounds (Lot R19A)	Average	39,695 CUP	2,401 ft/sec
	High	43,200 CUP	2,469 ft/sec
	Low	35,200 CUP	2,370 ft/sec

INITIAL DISTRIBUTION

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HQ USAF (RDPA)	1	USAF TAC FTR WPNS CNTR CRCD	1
AFSC (IGFG)	1	DDC	2
AFSC (DLTW)	1	CINCUSAFE (DMW)	1
AFSC (SDWM)	1	CINCUSAFE (OA)	1
ASD (TWT)	1	CINCPACAF (DMWXE)	4
ASD (TWD)	1	USAF TAWC (AY)	1
ASD (ENYS)	1	AMXAA USASASA	3
ASD (ENVW)	1	AX MCDEC	2
ASD (ENWS)	2	CSGMP	1
FTD (PDXA)	1	CAGIN-CM	1
AFML (LNP)	1	AMXRD-BVL	1
AFML (LPH)	1	AMXRD-HEL	1
AFML (LAM)	1	SMUFA	1
AFAL (LVA)	1	AMXST-CB	2
AFFDL (FBS)	1	AEC LIB	1
TAC (DMW)	1	DEPT OF ARMY CH R&D	1
TAC (DRFM)	1	BRL (AMXRD-BTL)	2
TAC (DNAN)	1	BRL (AMXBR-XBL)	1
SAC (OAI)	1	BRL ATTN R MCCOY	2
SAC (DMW)	1	BRL TECH LIB	1
WRAMA (MMEBL)	1	WATERVLIET ARSENAL	1
CIA	2	NAV WPNS LAB	1
AFWL (DOGL)	1	NAV WPNS CTR	1
AF SPEC COMM CNTR	2	AFIT TECH LIB	1
AUL (AUL-LSE-70-239)	1	4525 FTR WPNS WG FWOA	1
CH R&D CRDAM	1	USA R&D CTR (AMXRD-AD)	1
USA WPNS COMD ATTN ANSWEREW	1	NAV ORD SYS CODE ORD 0332	1
USA MATRL SYS ANALYS AGCY AMXRD-AS	1	NAV WPNS CTR COE 4063	1
USA MATRL SYS ANALYS AGCY AMXRD-AA	1	DIR RSCH LAB EDGEWOOD ARS	1
USA MATRL SYS ANALYS AGCY AMXRD-DB	1	PICATINNY ARS	1
USA ABERDEEN R&D CTR	1	AFSC TECH LIB	2
FRANKFORD ARSENAL	1	HQ PACAF (IGY)	1
PICATINNY ARS SMUPA-RT-S	1	DL	1
NAV AIR SYS COMD CODE AIR 350B	1	DLB	1
USN WPNS LAB CODE TR	1	DLG	1
USN NAV ORD LAB TECH LIB	1	DLY	1
USN ORD LAB CODE 730	2	DLR	1
NAV ORD STN	1	DLOSL	2
NAV WPNS STN CODE 64	1	DLRV	1
NAV SYS CNTR	1	DLRD	1
SAFETY RSCH CNTR	1	DLRW	1
USN WEA CNTR CODE 753	2	DLIM	1
USN WEA CNTR CODE 4585	1	DLII	1
USN SPNS EVAL FAC	1	DLDL	1
57 FTR SPN WG FWOA	1	DLDG	20
NAV AIR SYS COMD CODE AIR 5323	1	ADTC WE	1
NAV AIR SYS COMD CODE AIR 5324	1		
CH NAV OPRS	1		
USB RSCH LAB CODE 2027	1		
USN RSCH LAB CODE 5180	1		

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13. ABSTRACT The object of this program was to design and fabricate four demonstrator weapons to be used by the Air Force Armament Laboratory, Eglin Air Force Base, Florida, to prove the feasibility of its automatic weapon concept which utilizes the shooter's arm as the gunstock. Demonstrations proved the basic concept was not only feasible but exceeded expectations. Further efforts will be made to improve trigger pull, trigger guidance, pistol grip locking, the arm rest, sighting, and to modify the design for quantity production. The origin of the stockless rifle and machine gun is described in the publication, "Ordnance", American Ordnance Association, September - October 1970, under the title "A Novel Survival Weapon" by Dale M. Davis.			

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14	KEY WORDS	LINK A		LINK B		LINK C	
		ROLE	WT	ROLE	WT	ROLE	WT
	Lightweight Rifle/Submachine Gun Survival Weapon Shooter's Arm as Stock Gas-Operated Weapon Caliber .17 cartridge						

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